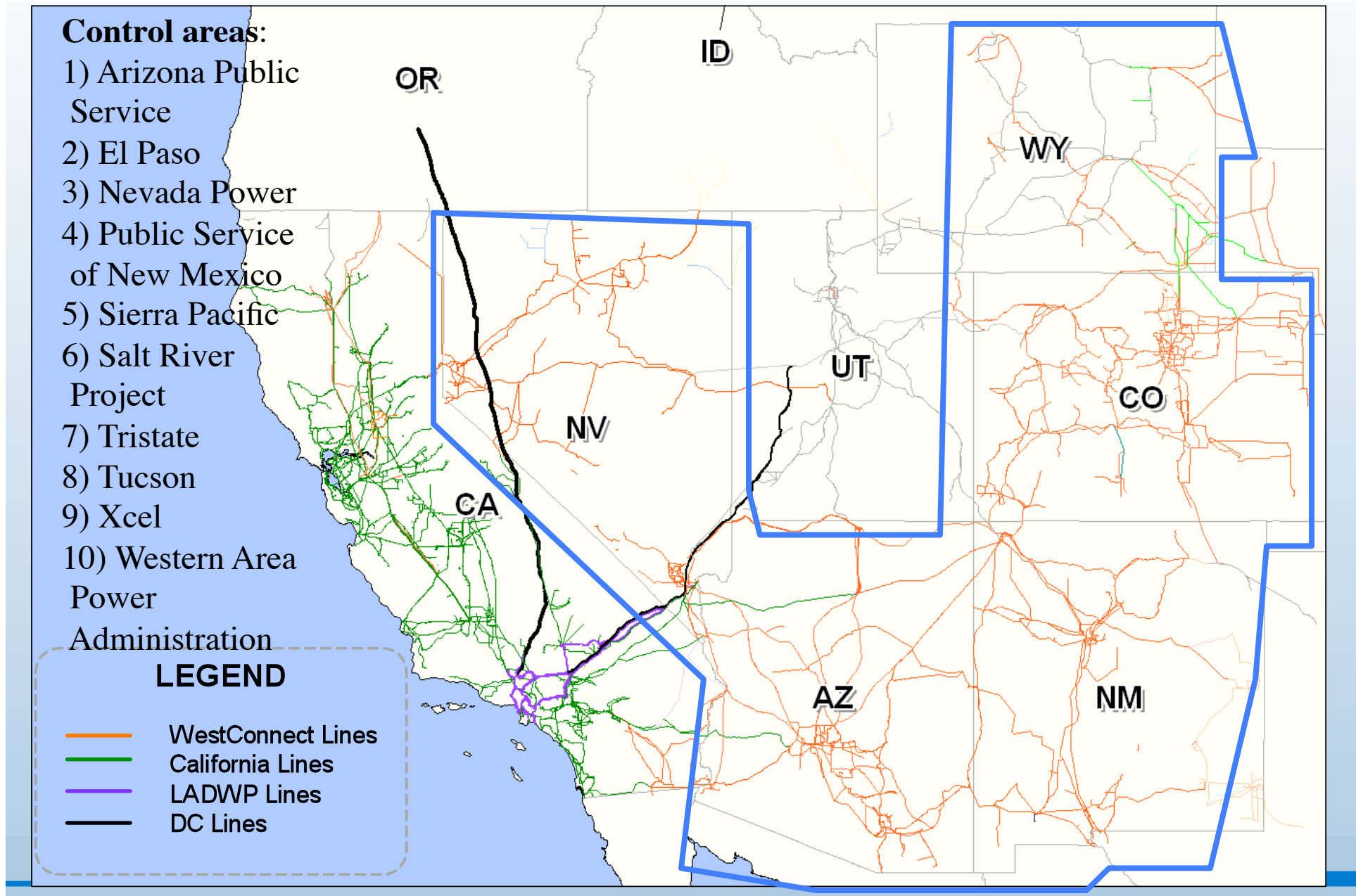




# Western Wind and Solar Integration Study

**Debbie Lew**  
**NREL**  
**July 25, 2008**

# Study Footprint (WestConnect outside of California)



# Overview

- Goal
  - To understand the costs and operating impacts due to the **variability** and **uncertainty** of wind, PV and concentrating solar power (CSP) on the grid
  - Not the cost of wind or solar generation
- Issues
  - Does geographic diversity help?
  - How do local resources compare to out-of-state resources
  - Can balancing area cooperation help manage variability?
  - What is the benefit of wind forecasting?
  - How can hydro help with wind integration?
- Scope of study
  - Operations, not transmission study
  - Study year – 2017 to line up with WECC studies
  - Simulate load and climate of 2004, 2005, 2006 forecast to 2017
  - Simulate all of WECC but all subhourly variability accommodated by WestConnect

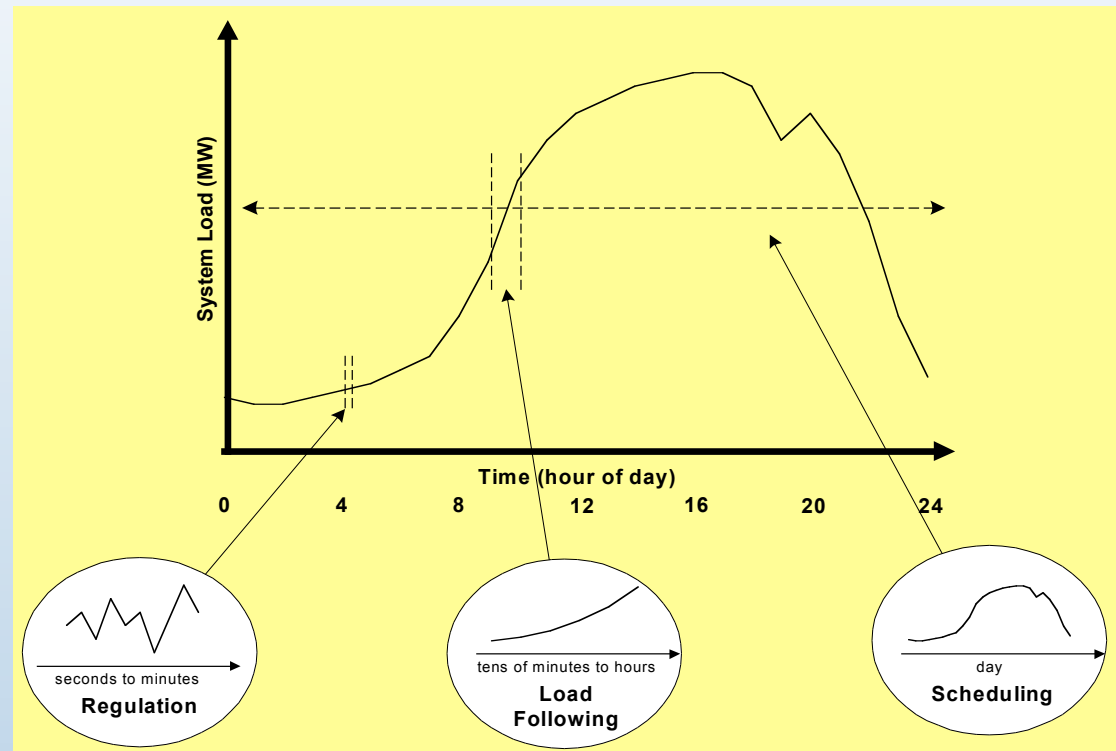


# High Renewables Basecase 2017

	Wind	Solar PV	Concentrating Solar Power	Total
Study footprint (WestConnect)	30% by energy	1.5%	3.5%	35%
	28,256 MW	2472 MW	2884 MW	33,613 MW
Rest of WECC	20%	0.9%	2.1%	23%
	36,767 MW	2895 MW	3378 MW	43,040 MW
Total	65,023 MW	5368 MW	6262 MW	76,654 MW

# Integration Study - Key Tasks

- Evaluate operating impacts and associated costs
  - Regulation
  - Load Following
  - Unit Commitment
- Evaluate reliability impacts
  - Effective Load Carrying Capability / Loss of Load Probability

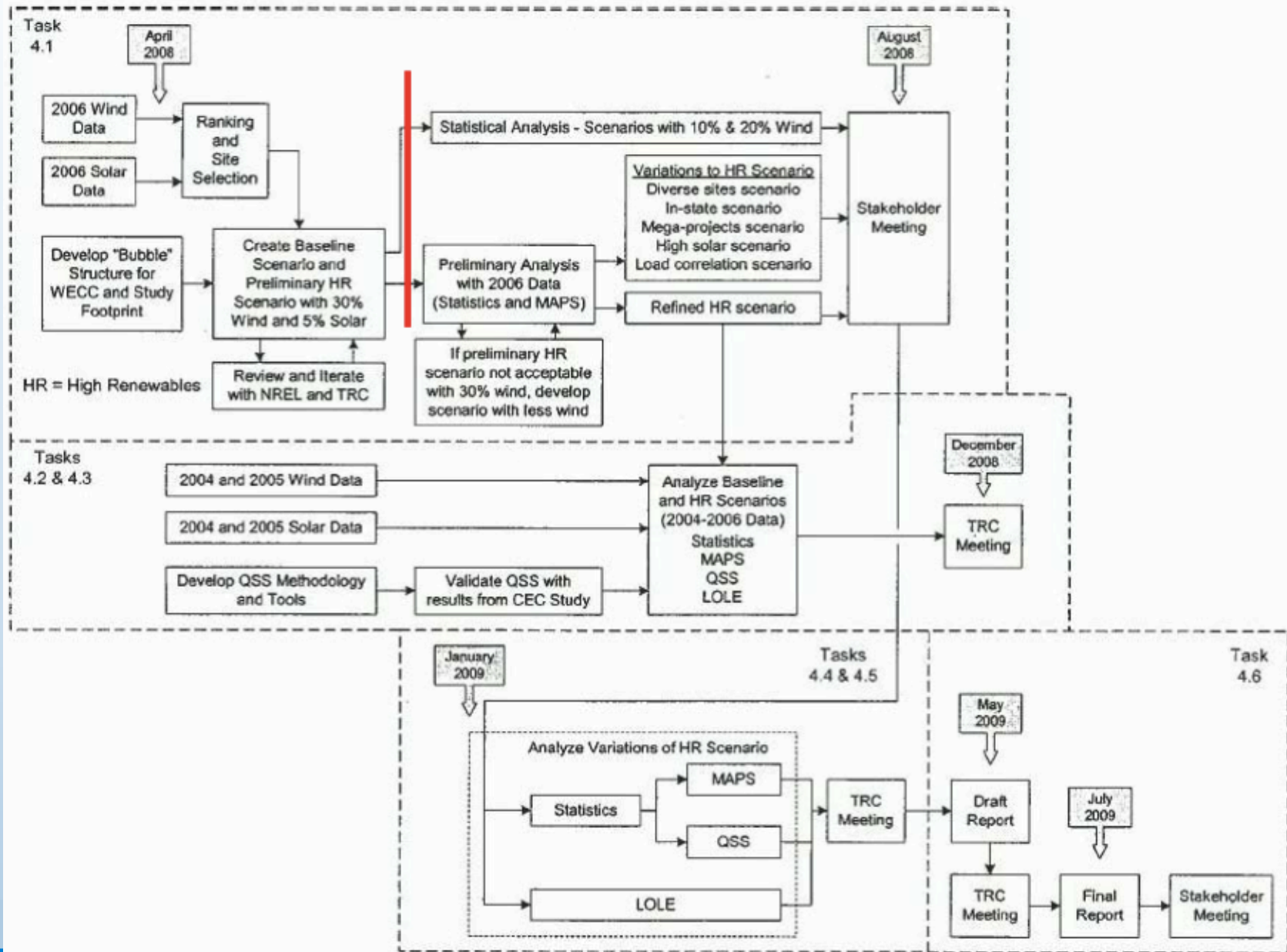


# Tasks and Schedule

- Stakeholder Meeting (5/23/07)
- Data Collection (until 5/08)
  - Wind and solar mesoscale modeling (3TIER)
  - Utility load, generator, transmission data (Exeter)
- Preliminary Analysis (3-7/08) - GE
  - Extensive statistical analysis with various options for wind/solar sites and transmission
- Scenario Development (8/08) - GE
  - In-state vs out-of-state resources
  - Geographically diverse resources
  - Mega projects
  - Best correlated with load
- Stakeholder Meeting (8/14/08)
- Run Scenarios (starting 8/08) - GE
  - Examine costs due to regulation, load following, unit commitment
  - “Dives” to investigate issues such as Hoover
  - Examine mitigation strategies/options
  - Determine contributions to reliability and capacity value
- Preliminary Technical Results (end ‘08)
- Reporting and Stakeholder Meeting (mid ‘09)

TRC calls held ~bimonthly

# GE Detailed Analysis Schedule



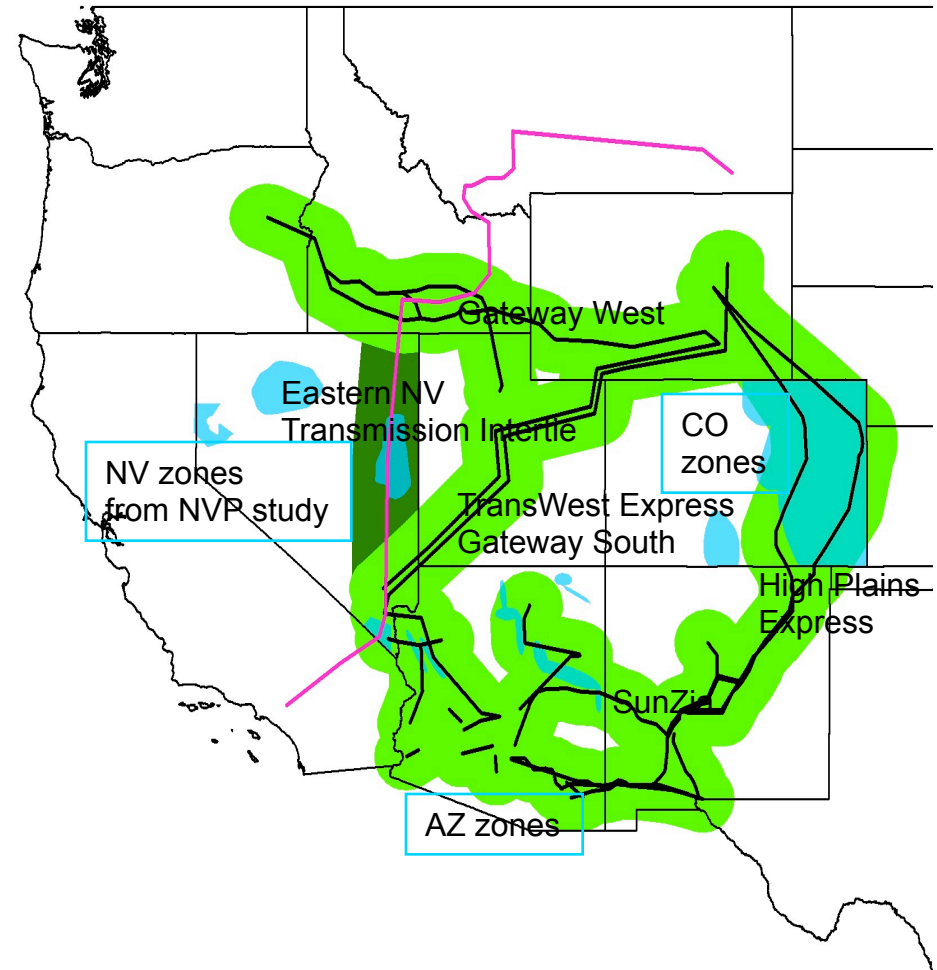
# Wind Data

- Previous data sets assembled from various years, measurements and assumptions
- Hired 3TIER to undertake largest wind mesomodeling to date
- Wind speed database (24TB)
  - Entire western US at 2km x 2km grid
  - 10, 20, 50, 100, and 200m hub heights
  - 10 minute intervals for 2004-6
- Wind power database (100's GB)
  - Selected 32,000 grid points
  - Each grid points holds 30 MW
  - Based on Vestas V90 3MW turbine and 3TIER's SCORE process
  - Hourly forecast for day-ahead wind output




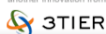
# Wind Site Selection

- 3TIER downselected from 1.2M to 30,000 points. GE will select final sites.
  - Exclusions - recreation, urban, forests, slopes, high elevation, etc. (NREL)
  - Preselected sites - existing or planned wind plants (Platts database/NREL)
  - Transmission corridors or zones (200 GW) - based on proposed new transmission and initial zone information (excl new NV zones)
  - Load correlation (250 GW) - best diurnal correlation with Westconnect load
  - Best resource (450 GW) - best wind power density
  - Additional sites added in to help validate model results



# Web-based interface for wind data

- Click on site and download 10 minute wind speed and wind power output data stream for selected periods
- Planned release in summer to be accompanied by webinars explaining use of database

 another innovation from  


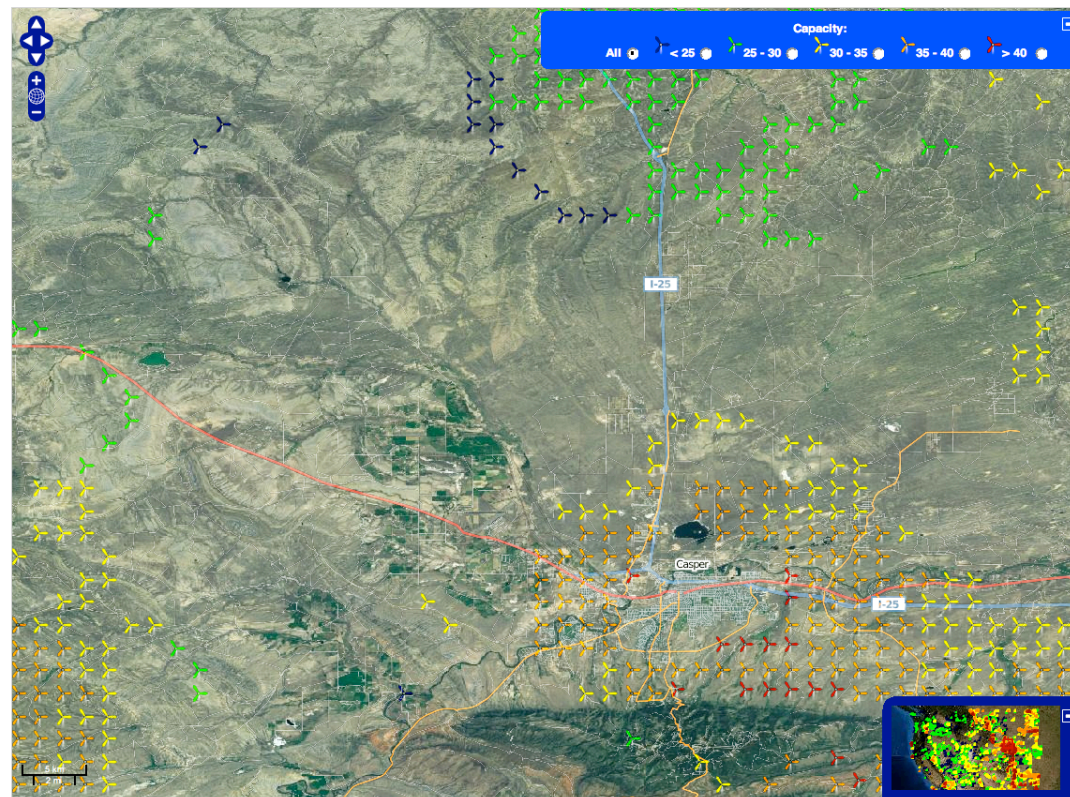
**Western Wind Integration Study**  
powered by 3TIER

This interface gives access to the 30,000+ sites that were modeled as part of the Western Wind and Solar Integration Study.

The data can be accessed in two ways:

- Use interactive map to zoom in and click on a turbine
- Choosing a Station ID from the metadata file and typing it into the form below

Enter Station Id:



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another innovation from 

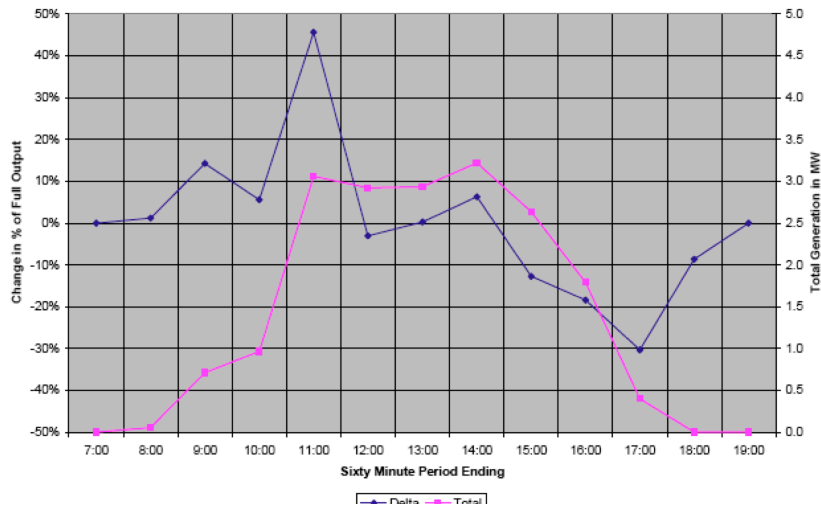
Laboratory

# Solar Modeling

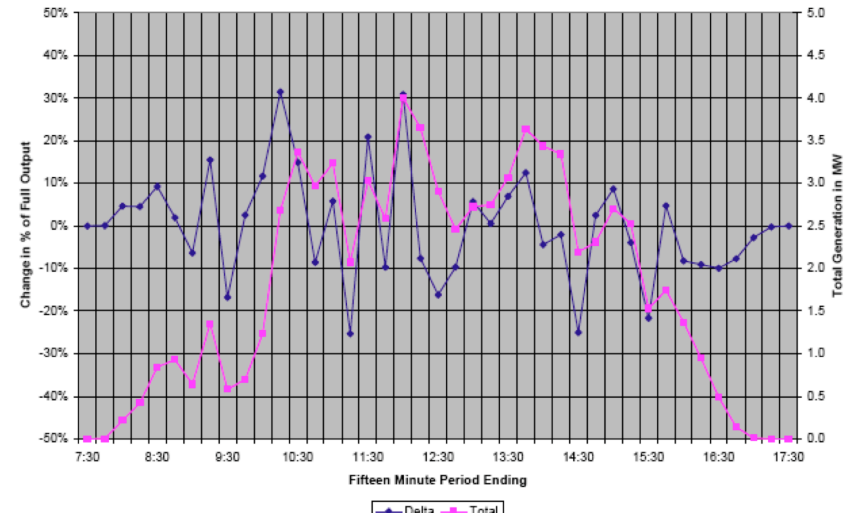
- Perez of SUNY ran solar model for US
  - 10km x 10 km grid
  - 1 hour intervals for 2004-2006
  - Direct normal and global insolation
  - Available at [http://rredc.nrel.gov/solar/old\\_data/nsrdb/1991-2005/](http://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/)
- PV Modeling
  - By weather station site (150 sites for western US)
  - Template of different orientations and tracking configurations
- Concentrating Solar Power (CSP) Modeling
  - Parabolic trough plants with 6 hours thermal molten salt storage, similar to APS Abengoa plant
  - Modeled over 200 GW of CSP sites
- Fast PV variations driving need for subhourly PV analysis

# Need for Subhourly PV Analysis

SGSSS 12/3/2005 60 Minute Power Changes for the Full System



SGSSS 12/3/2005 15 Minute Power Changes for the Full System



SGSSS 12/3/2006 1 Minute Power Changes for the Full System

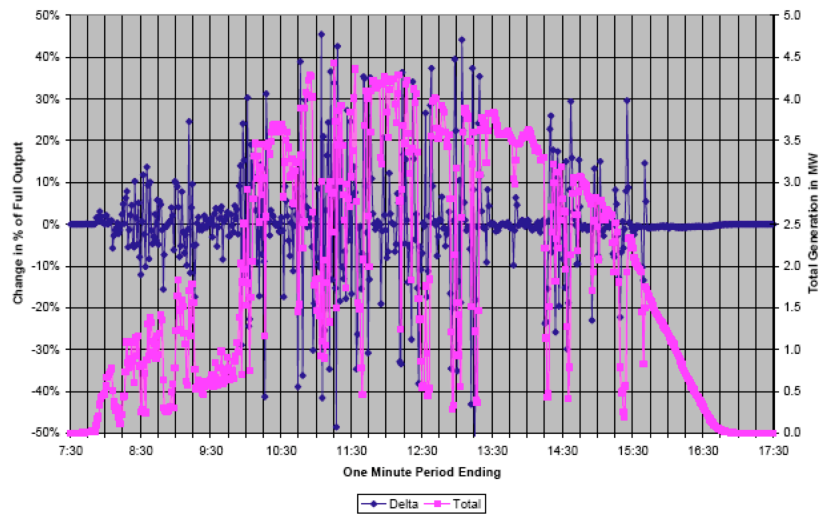


Figure 10

SGSSS 12/3/2005 10 Second Power Changes for the Full System

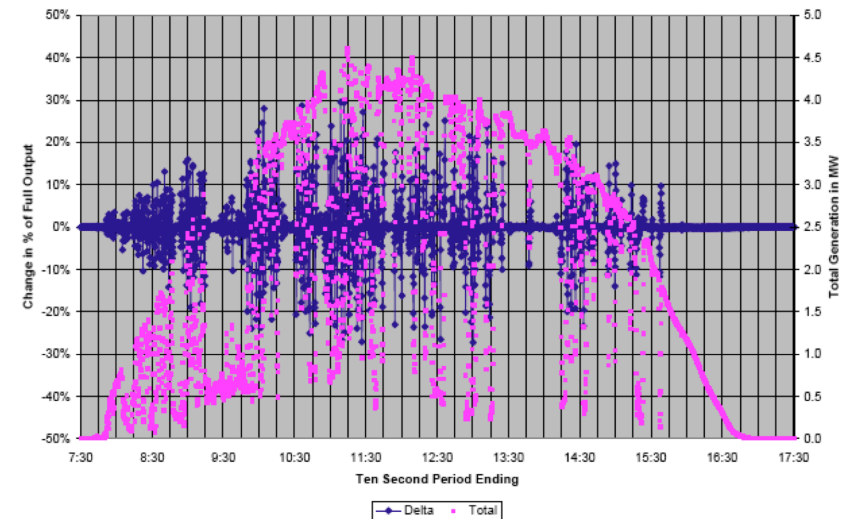


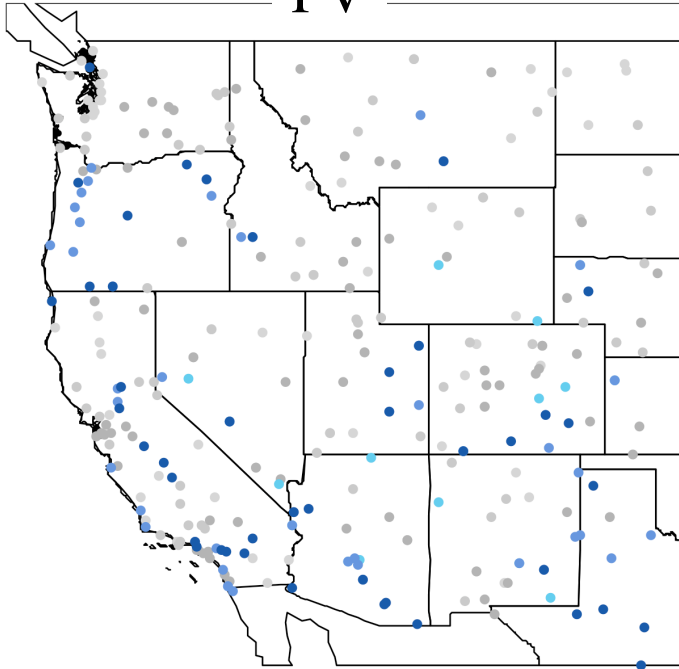
Figure 11

Source: Tom Hansen, Tucson Electric Power

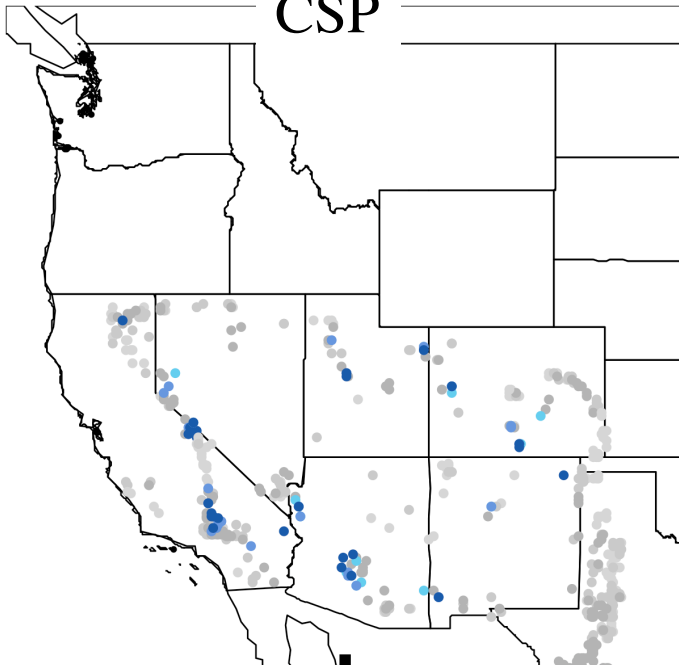
# Site Selection

## In-Area High Renewables Scenario

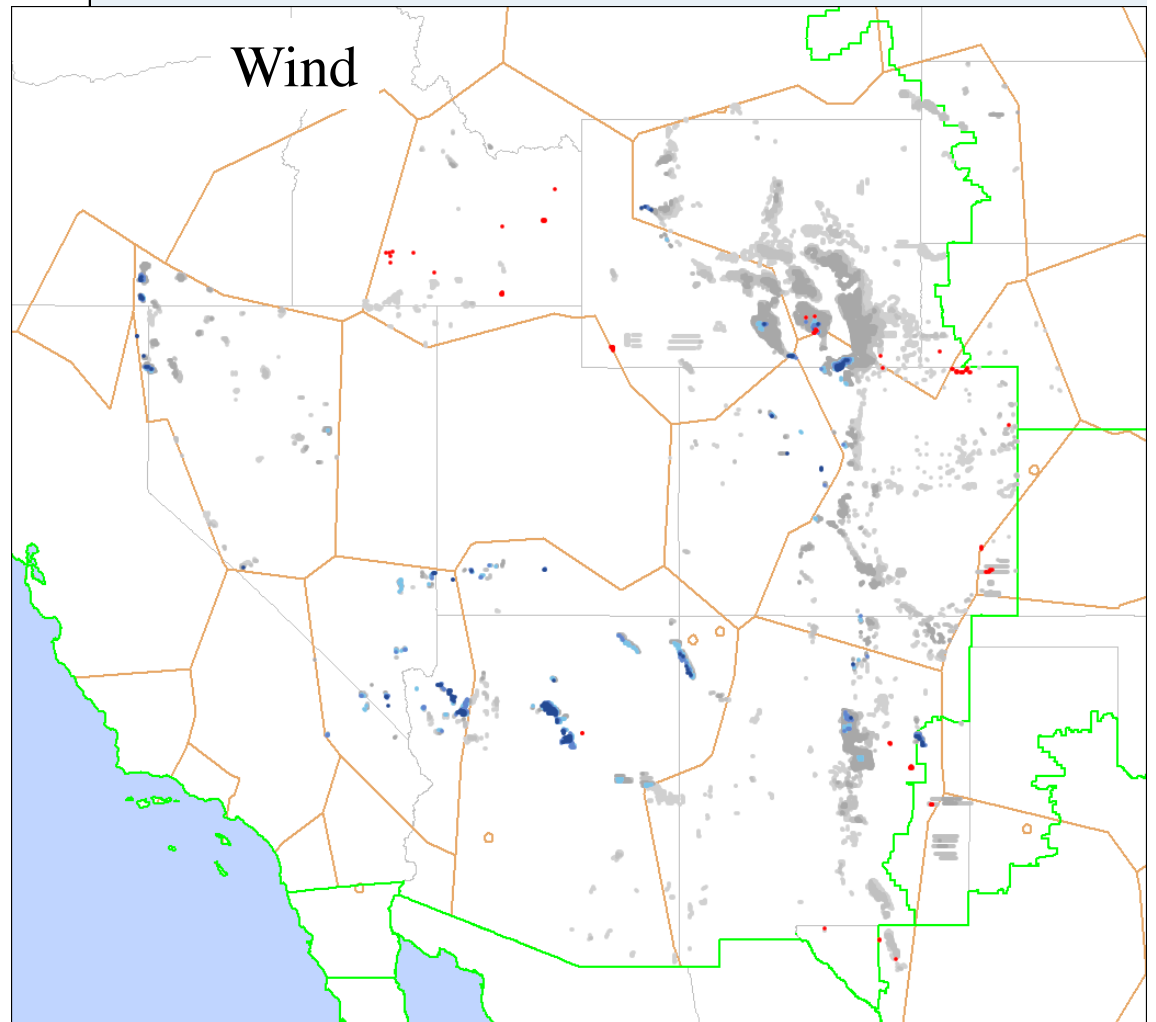
PV



CSP



Wind



# Stakeholder Meeting

August 14, Embassy Suites - Denver/Aurora

- Wind and Solar Modeling and Data
- Statistical analysis of Baseline and In-Area Renewables scenarios
  - 10/20/30% wind penetration by energy
  - Up to 5% solar penetration by energy, of which 70% CSP, 30% PV
  - Model significant renewables in the rest of WECC
- MAPS runs of baseline and in-area scenarios
- Propose additional scenarios
  - Least-cost of delivered energy; load correlation; high solar; etc.
- Stakeholder discussion and input

# Summary

- Wind mesomodel datasets are being validated and will be publicly available in summer 2008
- Stakeholder Meeting August 14, 2008 in Colorado
- Revised analysis timeline:
  - Preliminary results – TRC call in late 2008
  - Draft report – May 2009
  - Final report – July 2009